

Wind Input, Surface Dissipation and Directional Properties of Shoaling Waves

E.A. Terray

Department of Applied Ocean Physics and Engineering

MS-11, 217 Bigelow

Woods Hole Oceanographic Institution

Woods Hole, MA 02543

(508) 289-2438 (Voice), (508) 457-2194 (Fax)

eterray@whoi.edu

Award Number: N00014-97-1-0483

LONG-TERM GOAL

This project is a component of the multi-investigator, multi-institutional field study of shoaling surface waves, SHOWEX. The long-term goal of this program is to better understand the dynamics of wave evolution on the shelf, and to improve our predictive modeling capability. My component is closely integrated with another effort of the same name by a group at the University of Miami (see the 1988 Annual Progress Report by M.A. Donelan and H.C. Graber). The main SHOWEX experiment is scheduled for the fall of 1999 at Duck, N.C.

OBJECTIVES

Spectral wave models typically describe the evolution of wave energy or action as a function of fetch and duration. The rate of change of energy in each spectral band is the residual of the sum of various “source” terms that describe the rate of energy input from the wind, the transfer of energy across the wavenumber spectrum due to nonlinear interaction with other wave components, and dissipation (due both to wave breaking and to the drag exerted by the bottom). The data obtained in SHOWEX will be used to establish the evolution of the energy balance in the wave field from the shelf break to the nearshore region.

APPROACH

Measurements of wave height and direction, as well as meteorological forcing, and the near-surface rate of turbulent energy dissipation will be obtained from an array of three ASIS (Air-Sea Interaction Spar) buoys, and a SWATH (Small Waterplane Area Twin Hull) ship (Donelan and Graber, 1998). Other investigators are responsible for measuring wave dissipation via breaking and bottom friction, as well as providing additional measurements of wave evolution

The component reported here is responsible for near-surface turbulence measurements from the ASIS buoys and the SWATH ship, and for ADCP current profiling in the vicinity of one of the buoys.

WORK COMPLETED

Of the three topics listed above, during 1998 we focused mainly on the measurements from the ASIS buoys.

The difficulty of placing instruments close to the surface in all but the lowest sea states has been a long-standing problem in air-sea interaction research. Several years ago, in collaboration with Drs. M.A. Donelan and H.C. Graber (RSMAS, University of Miami), we began development of a new Air-Sea Interaction Spar buoy (ASIS). The main design criteria we imposed were that the buoy provide an approximately surface-following platform that minimally disturbs the flows of air and water about it. These considerations lead us to design a short spar that is heavily damped in heave. In order to keep the sizes of individual structural elements as small as possible, we separated the usual vertical spar into five slender columns, which are tied together at a distance of several meters both above and below the mean waterline. A discussion of the design criteria and the performance of the buoy at sea are contained in Graber *et al.*, (1995, 1998). A photograph of an ASIS buoy at sea is shown in Figure 1. We have gained experience with this design through a deployment in the Gulf of Mexico, and more recently during the FETCH experiment in the Gulf de Lion (the latter was a collaborative effort with CNRS/CETP, funded by MAST). As a result of these efforts we now have a good understanding of the response of the ASIS to wind and wave forcing.

As part of the overall ASIS buoy effort in SHOWEX, we have constructed two new buoys, and have developed a new data acquisition system for the buoy that can handle a large number of instruments that use asynchronous serial I/O. Because the rate gyros and accelerometers we use to measure the buoy's motion are analog, we have also developed a means to synchronize the sampling of both analog and digital instruments based on GPS. Turbulence from the buoys will be measured using SonTek ADVs. We have examined the noise characteristics and phase stability of these instruments by means of calibrations in a towing channel.

We have also investigated the use of conventional upward-looking ADCPs to measure wave height and direction as well as current. The success of this approach will increase the number of fixed locations from which we can acquire wave measurements in the field (Terray *et al.*, 1997, 1998).

RESULTS

The work described above has lead to the following results:

- [1] We now have a good understanding of the at-sea performance of the ASIS buoy. This work has been accepted (with revisions) for publication (Graber *et al.*, 1998).
- [2] We have constructed two additional ASIS buoys, and have improved the data acquisition capability to include 8 additional "digital" instruments.
- [3] We have shown that in moderate depth water, conventional ADCPs perform well in measuring wave height and direction. Results from this work were presented at the recent Coastal Processes Symposium, and at Oceanology International'98.

REFERENCES

M.A. Donelan and H.C. Graber, 1998: FY98 ONR Annual Report.

Graber, H.C., E.A. Terray, M.A. Donelan, J. VanLeer and W.M. Drennan, 1995: A lightweight multi-spar buoy – Design and sea trials. Technical Report RSMAS 95-009, Rosenstiel School of Marine and Atmospheric Science, University of Miami.

Terray, E.A., R. Lee Gordon and B.H. Brumley, 1997: Measuring wave height and direction using upward-looking ADCPs. Oceans'97 MTS/IEEE Proceedings, pp. 287-290, IEEE Press.

PUBLICATIONS

Graber, H.C., E.A. Terray, M.A. Donelan, W.M. Drennan, J. VanLeer and D. Peters, 1998: ASIS – A new Air-Sea Interaction Spar buoy: Design and Performance at Sea. *J. Atmos. and Oceanic Technol.* (accepted with revision).

Terray, E.A., B.H. Brumley and R. Lee Gordon, 1998: Measuring waves and currents with an upward-looking ADCP. Proc. Coastal Ocean Processes Symposium, 27-30 September, 1998, Woods Hole Oceanographic Institution (to be published)

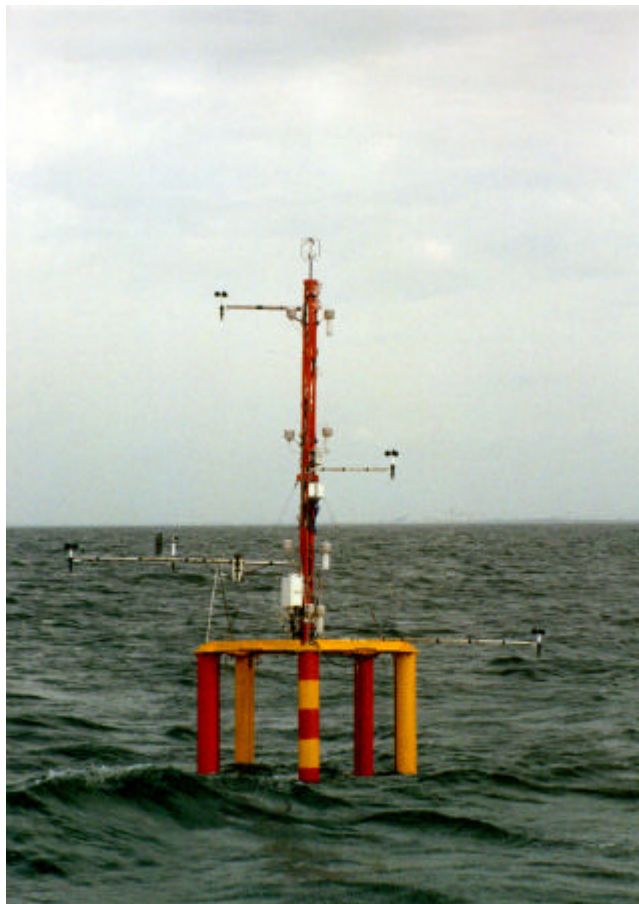


Figure 1. ASIS buoy showing standard suite of meteorological sensors (including a sonic anemometer atop the mast. An array of 8 wave gages is contained within the pentagonal cage (Graber *et al.*, 1998)